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Farmer Perspectives on Agroforestry Opportunities and Constraints in Cape Verde

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In the Água de Gato Watershed on the island of Santiago, Cape Verde Islands, 51 farmers were surveyed regarding their attitudes and knowledge of agroforestry. The farmers identified eight constraints to agroforestry implementation, with virtually all indicating that a source of loan funds was the major concern. Space or land constraints and availability of tree seedlings were identified as constraints by 94% and 88%, respectively. Despite these concerns, 92% of the farmers expressed a willingness to adopt or improve agroforestry practices in the watershed, with 73% expressing a willingness to establish fruit trees, 53% willing to establish trees or shrubs for fuelwood, and 16% willing to plant trees for shade.

Keywords: Africa, agroforestry, extension, farming systems

INTRODUCTION

Cape Verde is a small country consisting of 10 islands and eight islets, located about 455 km from the west coast of Africa (Figure 1). All the islands are arid to semi-arid, with a summer rainy season during which most agricultural production occurs. In Cape Verde, only 10% of the total land area is suitable for agriculture. The country has about 2,000 ha of irrigated agricultural land and an additional 38,000 ha of rainfed agricultural land. Most agriculture is for subsistence purposes and, in years of average or higher rainfall, can account for as much as 40% of the domestic food consumption. Although the agriculture sector employs 50% of the country's population, it generates only 15% of the gross domestic product (Vera Cruz *et al*. 1994).

Cape Verde is, for the most part, unforested. Scattered trees are common along roadsides and in villages for shade. Likewise, some fruit trees are included with agricultural lands, with mango (*Manguifera indica*), avocado (*Persea americana*),

coconut (*Cocos nucifera*), and breadfruit (*Artocarpus altilus*) most common. There is tremendous pressure on the wood resources for cooking fuel, and it is common for rural dwellers to travel great distances in the daily search for fuel. Some fuelwood plantations have been established and maintained by governmental agencies. On the northernmost island of Santo Antáo, a temperate, mostly coniferous, protection forest has been established at high elevations. This impressive forest, which is still being developed, provides a modest supply of wood products, including fuel and lumber. Its main purposes are to trap rainfall and moisture from fog, slow runoff and reduce erosion.

Figure 1. Location of the Água de Gato Watershed on the Cape Verdean island of Santiago

Agroforestry is a hybrid land-use system (Huxley 1982), and it usually involves the addition of an agricultural system (agronomic or pastoral) into a forest landscape, or the incorporation of trees into an agricultural landscape. In either case, success hinges upon the ability of the new system to meet the end user's needs, e.g. increased economic returns (Thatcher *et al.* 1997, Mary *et al.* 1999), reduced labour (Ketterings *et al*. 1999), taking advantage of existing knowledge and capabilities (Den Biggelar and Gold 1995, Walker *et al.* 1995, Thapa *et al*. 1995), and positive environmental benefits (King 1979, Swinkels *et al*. 2002).

During 1994, the U.S. Agency for International Development (USAID) initiated a project under the Sustainable Agriculture and National Resources Management Collaborative Research Support Program (SANREM CRSP). One of the objectives of the project was to support research that would assist in the development of sustainable farming systems. USAID had already begun watershed-level research in the Água de Gato Watershed, located on the southernmost island of Santiago (Figure 1). Likewise, the SANREM CRSP project was centred in the Água de Gato Watershed. During 1994, project scientists, in cooperation with the Cape Verde National Institute for Agricultural Research and Development (INIDA), conducted a Participatory Landscape/Lifescape Appraisal (PLLA) with local farmers. From this PLLA, a host of research objectives were identified, including the development of agroforestry systems that would enhance the diversity of products on farms in the watershed.

Based on general information from the PLLA, a more detailed survey of farmers in the watershed was needed to identify the opportunities for and constraints to agroforestry implementation. The study reported here was established to meet that need. Through direct interviews with farmers, it would be possible to learn of their willingness to plant more trees and to identify any constraints that would have to be overcome to ensure success of agroforestry implementation. Thus, the objectives of this research were:

- to determine the willingness of Cape Verdean farmers to plant more trees as part of their farming operations; and
- to determine economic, biological and logistical constraints to more tree planting as perceived by Cape Verdean farmers.

LOCATION AND CHARACTERISTICS OF THE STUDY AREA

The 350-ha Água de Gato Watershed is located in southern Santiago (Figure 1). The watershed consists of steep terrain, with elevations ranging from 350 to 750 metres above sea level. The volcanic soils are only weakly developed, and are of basaltic origin with feldspathic mineralogy (Silva *et al*. 1981). The soils are highly erodible, and rich in mineral nutrients but low in nitrogen and organic matter. Climatically, the watershed is situated in a transition between the sub-humid and semi-arid zones. The annual precipitation of 250 to 600 mm falls mainly during July to September.

The Água de Gato Watershed is classified as an herbaceous steppe, with few shrubs and trees. Most trees are fruit trees, with mango the most common. Other common trees include mahogany (*Khaya senegalensis*), silk cotton tree (*Ceiba pentandra*), mesquite (*Prosopsis juliflora*), eucalyptus (*Eucalyptus camaldulensis*),

and umbrella mulga (*Acacia holosericea*). Wood and other organic matter are routinely burned for fuel by inhabitants of the watershed, so there is a great deal of pressure on the limited tree resource.

Both irrigated and rainfed agriculture are practiced in the watershed. Irrigated agriculture is confined to the best soils on the bottomlands, while rainfed agriculture is practiced on the side slopes and ridges. Two agroforestry systems are in use in the watershed, namely home gardens and multi-storey tree gardens. On steep hillsides, shifting cultivation is sometimes used. In this system, the land is cultivated for a few years until soil fertility fails due to erosion and loss of nutrients, after which the land is left fallow for a few years before being cultivated again. Sometimes the erosion is so severe that the land is forsaken for agricultural use.

The Água de Gato Watershed has 957 inhabitants in 177 families (Vera Cruz *et al*. 1994). Agriculture and animal husbandry are the principal occupations, primarily on a subsistence level. Some inhabitants are employed by a federal agency that conducts conservation and rural development projects, such as construction of roads, schools, irrigation channels, hillside terraces and check dams. The Catholic Church owns about half the land in the watershed, which is mostly rented back to the farmers. Individual farmers may work their own land, rent land out to others, work land rented from others, or sharecrop with other farmers. Under the sharecrop arrangement, the farmer works the land and provides a portion of the harvest to the owner, usually on a 50:50 basis. In this case, the farmer provides the labour and other costs of production, and recovers half of the crop.

RESEARCH METHOD

Fifty-one farmers – comprising 45 men and six women – in the Água de Gato Watershed were interviewed to determine their farming practices, their knowledge of and interest in agroforestry, and their personal backgrounds. This sample represents nearly 29% of the farms in the watershed. The interviews were conducted in Creole, the native language of the islands, with responses translated to Portuguese and then translated to English at the time of data entry. Farmers were selected by simple random sampling, and interview schedules arranged for their convenience. Interviews generally took about one hour to conduct. All interviews were conducted by a native Cape Verdean, and each farmer was told that the purpose of the interview was to collect information only. The questionnaire was initially developed by researchers, and was tested on two farmers for its clarity. Small modifications were made prior to administering the questionnaire to the full sample. The questionnaire solicited information on farming practices; agroforestry practices, knowledge and interest; educational needs; and personal background of the farmers. Since the interviews were arranged and administered face-to-face, the sample response rate could be considered to be 100 percent. All farmers who were contacted agreed to the interview.

Statistical analyses were performed on the farmer characteristic data. Farmers were grouped according to their willingness to plant trees for three uses – fuelwood, fruit production and shade. Differences between the willingness groups were investigated using one-way analysis of variance for the continuous variables and the Chi-square contingency tests for discrete variables. Continuous variables included

age, family size, farm area owned, farm area rented and area in partnership. Discrete variables included gender, marital status, willingness to plant trees and currently growing trees. All statistical analyses were performed using the Minitab statistical program.

SURVEY FINDINGS

Results are grouped into characteristics of farms and farmers in the study area, followed by the relationship between these characteristics and the attitudes farmers hold toward the implementation of agroforestry. In general, farmers were strongly supportive of agroforestry and increased tree planting, primarily for fruit and fuelwood. In most cases, farm and farmer characteristics were unrelated to willingness to plant trees. A notable exception occurred with tree planting for fruit – males were more willing than females to plant trees for fruit, and married farmers were more supportive than unmarried farmers.

Characteristics of Farmers

Of the 51 respondents, the oldest was 86 years old and the youngest 22 years, and the mean age was 51 years. Forty-five of the farmers were married, and the mean number of people per family was eight (range two to 14). Normally, two to four generations live in the same house complex, since traditionally the sons care for their parents when they become old.

All the farmers worked in the watershed, but eight of them also undertook work in villages outside the watershed. Twenty-seven of the farmers worked for the Frentes de Alta Intensidade de Mão de Obra (FAIMO), a federal public works agency, except that in high rainfall years all workers are released to make the labour available to the agricultural sector. The remaining farmers worked either on their own land or for other farmers in the watershed. The farmers working for FAIMO also did some work on their own lands and the land of other farmers during weekends and in the evenings, especially during the rainy season when labour needs reach a peak. Of those farmers, only 28 worked all year round on their own farms, mostly using irrigated land. The others worked on their farms on rainfed lands only during the rainy season, mostly from July to December.

All the farmers were involved in raising animals. The most common animals raised in the Água de Gato Watershed were chickens, goats, pigs and cows, averaging in number 16, 3, 3 and 1 per farmer, respectively. Besides raising chickens as a part of the farming subsistence system, some farmers raised large numbers of chickens for commercial purposes. The largest chicken producer in the survey tended a flock of 300. The responsibility for the animal feeding was divided among all the family members. The feeding of cows was more the responsibility of men, while pigs, goats and chickens were tended mostly by women and children, although whoever had free time was expected to feed the animals. Small children were not allowed to feed cattle in order to avoid injuries.

Fuelwood, a scarce resource in the watershed, was the main source of energy used for food preparation. Electricity, which is cleaner and uses less land that competes with agriculture, was not commonly used. The main plant species currently being used for fuel by the Água de Gato's farmers as fuelwood are mesquite

(*Dichrostachys cineria*), lantana (*Lantana camera*), maguey (*Furcraea foetida*), *Eucalyptus* species, and giant reed grass (*Arundo donax*). Five farmers used only fuelwood, the remainder using fuelwood in combination with bottled gas. Some farmers also used prunings from fruit trees, plant residues, cow dung and kerosene. More than half the farmers (51%) collected fuelwood outside their farms and had to walk up to 12 km to reach the source. Fuelwood gathering was mainly a responsibility of the women and children, who spent an average of eight hours weekly on this activity, but also involved men. Forty-three percent of farmers also purchased fuelwood, from other farmers or from government agencies, at an average price of 8 US cents per kg, varying with the species and quality. Families used an average of 13 kg of fuelwood daily for food preparation. The fuelwood market, though small, is strong. The greatest potential for improving the sale of wood for fuel is the development of small woodlots. This is currently being done on government lands, and to a minor degree on private lands. Since the demand for fuel is so high, security concerns are a problem. Forest rangers live in the woodlots to discourage illegal cutting of trees. One farmer in the watershed was using biogas, a source of energy that can be expanded, taking into consideration the number of animals being raised by each farmer.

Although agroforestry was a new word to most of the farmers, the system as a land-use was well represented in the irrigated lands. Ninety-eight percent of the farmers surveyed showed interest in soil conservation practices as a means of protecting their lands from future degradation. Eighty-eight percent had an interest in growing more trees on their farms, the main purposes reported being fruit and fuelwood production and shade. As with animal feeding, the weeding and watering of trees was a whole-family responsibility. Most of the farmers thought tree seedlings should be provided by the government, since they did not have enough money to purchase seedlings. Half the farmers surveyed felt that the farmers should be the ones to do the planting and be responsible for the costs of planting and maintenance. All farmers were interested in more education about agroforestry. When given a choice of several different educational activities, 69% preferred an outdoor field activity, 10% preferred an indoor workshop or seminar, 8% preferred a videotape, and 14% preferred a written publication.

Characteristics of Farms

Most of the farms in the watershed were rainfed, and the main crops, usually of subsistence nature, were corn and beans. A small area at the lower end of the watershed, where water is available, is irrigated. Sugar cane, bananas, vegetables and fruit trees (especially mango), often grown for cash, constituted the main irrigated crops.

The mean farm area owned by each farmer surveyed in the Água de Gato Watershed was 1.1 ha, ranging from 0 to 8 ha per farmer (Table 1). Overall, each farmer in the watershed was working an area between 0.3 and 5 ha, averaging 1.9 ha. Although some farmers from the surveyed group did not own any land, all of them worked a piece of land – owned, rented or worked in partnership – where they grew some food, especially for subsistence. The mean working area was greater than the area owned, since many farmers rented land from the Catholic Church.

Table 1. Land area statistics of farm size in the Água de Gato Watershed (ha)

Land tenure	Mean	Range	Standard Deviation
Area owned	1.1	0.0-8.0	1.9
Area rented from others	0.7	0.0-2.1	0.7
Area rented to others	0.1	0.0-2.0	0.4
Area worked in partnership	0.4	0.0-3.0	0.7
Total working area	1.9	0.3-5.0	1.2

Due to the high price and limited availability, artificial fertilisation was used only in irrigated lands by 45% of the farmers. Manure, which is cheaper and available in the watershed, was used by 58% of the farmers in irrigated lands and 37% in rainfed lands. A total of 12 farmers used neither artificial fertiliser nor manure on their lands. The low utilisation of fertiliser was caused not only by the high price, but also by the low water availability in most of those sites.

Relating Characteristics of Farmers and Farms to Attitudes toward Agroforestry

The results of the survey of farmers revealed a strong desire for implementation of agroforestry in the watershed. Of the 51 farmers surveyed, 92% stated they would like to see agroforestry implemented in their lands, and the remaining 8% were uncertain.

Although the majority of the farmers surveyed expressed a willingness to adopt an agroforestry system, they also recognised the existence of constraints that slow development of agriculture in the watershed. These constraints, if not solved, could also hinder adoption of agroforestry. In order of importance, the constraints were identified as: need for a line of credit (100%), land and space availability (94%), availability of seedlings (88%), need for incentives (84%), land and water availability for nursery implementation (61%), land and tree tenure (55%), laws (20%), and the need for technical support (18%). Other lesser constraints included the need for more help, availability of pesticides, seedlings damaged by people and animals, lack of money, and lack of rain. None of these were mentioned by more than 6% of the farmers surveyed.

Twenty-seven of the farmers surveyed (53%) expressed a willingness to plant more trees for fuelwood production. Although this group tended to be younger than the group unwilling to plant more fuelwood trees (mean age 49 versus 53 years), the difference was not significant (Table 2). Farm size and family size did not appear to affect willingness to plant fuelwood trees, although the willing farmers tended to control somewhat more land, since they owned outright and had partnerships on an average of 1.58 ha, compared to 1.48 ha for the unwilling farmers. There was a tendency for farmers who rented more land to be less willing to plant fuelwood trees.

Males were about evenly split between their willingness and unwillingness to plant more fuelwood trees, 23 vs. 22, respectively (Table 3). Although willingness to plant more fruit trees was not related to willingness to plant more fuelwood trees, the willingness of farmers to plant more shade trees was.

Table 2. One-way analysis of variance results for continuous variables related to willingness of farmers to plant more trees for fuelwood production

Variable	Unwilling to plant trees			Willing to plant trees			F	p
	N	Mean	SD	N	Mean	SD		
Age (years)	24	53.40	16.40	27	48.80	15.70	1.03	0.32
Family size (persons)	24	7.80	3.10	27	7.70	2.60	0.03	0.87
Farm area owned (ha)	24	1.12	1.49	27	1.14	2.17	0.00	0.97
Farm area rented from (ha)	24	0.78	0.66	27	0.71	0.75	0.12	0.73
Area farmed in partnership ha)	24	0.36	0.50	27	0.44	0.82	0.17	0.68

Table 3. Contingency table and chi-square statistics for classification variables related to willingness of farmers to plant more trees for fuelwood production

Variable	Category	Fuelwood willingness count		χ^2	p
		Unwilling	Willing		
Gender	Male	22	23	0.51	0.47
	Female	2	4		
Marital status	Unmarried	3	3	0.2	0.88
	Married	21	24		
Willingness to plant fruit trees	No	8	6	0.79	0.37
	Yes	16	21		
Willingness to plant shade trees	No	24	19	8.43	0.00
	Yes	0	8		
Currently growing fruit trees	No	7	6	0.32	0.57
	Yes	17	21		

Thirty-seven of the farmers surveyed (73%) expressed a willingness to plant more trees for fruit production. Age seems not to have an effect on the willingness to plant more trees for fruit production ($p = 0.92$), the mean age being 51 years for both groups (Table 4). Also, farm size and family size did not have a significant effect on willingness to plant fruit trees (Table 4). The willing farmers controlled almost the same area as the unwilling; they owned outright and had partnerships on an average of 1.54 ha, compared to 1.50 ha for the unwilling farmers. Males were more willing to plant fruit trees than females. While males willing to plant fruit trees had a ratio of 3.5:1, females had a ratio of 0.2:1 (Table 5), probably due to the fact that fruit is a cash crop and often men control cash returns in the rural areas.

Table 4. One-way analysis of variance results for continuous variables related to willingness of farmers to plant more trees for fruit production

Variable	Unwilling to plant trees			Willing to plant trees			F	p
	N	Mean	SD	N	Mean	SD		
Age (years)	14	51.40	19.30	37	50.80	14.90	0.01	0.92
Family size (persons)	14	7.10	2.70	37	8.00	2.90	1.15	0.29
Farm area owned (ha)	14	0.99	1.84	37	1.18	1.89	0.11	0.74
Farm area rented from (ha)	14	0.65	0.46	37	0.78	0.77	0.32	0.58
Area farmed in partnership (ha)	14	0.51	0.51	37	0.36	0.74	0.48	0.49

Table 5. Contingency table and chi-square statistics for classification variables related to willingness of farmers to plant more trees for fruit production

Variable	Classification	Fruit tree willingness count		χ^2	p
		Unwilling	Willing		
Gender	Male	10	35	5.25	0.02
	Female	4	2		
Marital status	Unmarried	4	2	5.25	0.02
	Married	10	35		
Willingness to plant fuelwood trees	No	8	16	0.79	0.39
	Yes	6	21		
Willingness to plant shade trees	No	11	32	0.48	0.49
	Yes	3	5		
Currently growing fruit trees	No	3	11	0.17	0.68
	Yes	10	27		

Only eight of the farmers surveyed (16%) expressed a willingness to plant more trees for shade. Farm size and family size did not have a significant effect on willingness to plant shade trees (Table 6), although the willing farmers tended to control somewhat more land, since they owned outright and had partnerships on an average of 1.86 ha, compared to 1.46 ha for the unwilling farmers. Gender seems not to have influenced the willingness to plant more trees for shade. Although the female sample was quite small, five females were unwilling to plant more shade trees, and only one was willing. Only seven males expressed a willingness to plant shade trees, while 38 did not (Table 7). This is probably related to the fact that most

houses in the watershed already had one or more shade trees in their yards. All unmarried farmers were unwilling to plant trees for shade. This is probably related to the location in the watershed where farmers plant shade trees. Often they plant them in their yards, and unmarried people do not generally own houses. The same number of farmers willing to plant shade trees were willing to plant fruit trees or already were growing fruit trees.

Table 6. One-way analysis of variance results for continuous variables related to willingness of farmers to plant more trees for shade

	Unwilling to Plant Trees			Willing to Plant Trees			F	p
Variable	N	Mean	SD	N	Mean	SD		
Age (yr)	43	51.23	16.62	8	49.50	13.43	0.08	0.78
Family size (persons)	43	7.84	2.89	8	7.38	2.67	0.18	0.68
Farm area owned (ha)	43	1.09	1.69	8	1.31	2.74	0.09	0.76
Farm area rented from (ha)	43	0.74	0.69	8	0.75	0.81	0.00	0.97
Area farmed in partnership (ha)	43	0.37	0.61	8	0.55	1.03	0.46	0.50

Table 7. Contingency table and chi-square statistics for classification variables related to willingness of farmers to plant more trees for shade

		Shade Tree Willingness Count		χ^2	p
Variable	Classification	Unwilling	Willing		
Gender	Male	38	7	0.01	0.94
	Female	5	1		
Marital status	Unmarried	6	0	1.27	0.26
	Married	37	8		
Willingness to plant fuelwood trees	No	24	0	8.43	0.00
	Yes	19	8		
Willingness to plant fruit trees	No	11	3	0.48	0.49
	Yes	32	5		
Currently growing fruit trees	No	10	3	0.72	0.40
	Yes	33	5		

DISCUSSION

In the early stages of promoting a new land-use practice, it is essential to assess the current conditions and understand the end users who will ultimately determine the success or failure of the endeavour. In this case, the farmers in the Água de Gato Watershed, through the PLLA process, indicated a strong interest in additional planting of trees and incorporation of trees into the agricultural enterprise. However, farmers were not knowledgeable about agroforestry as a land-use practice or about the various agroforestry models that may be applied in the watershed. The fact that 92% of the farmers in this survey indicated a willingness to plant more trees for one or more purposes is telling evidence that the potential for agroforestry implementation may be strong.

Constraints to agroforestry implementation identified by the Cape Verdean farmers mirror those of farmers elsewhere (Erskine 1991, Franzel *et al*. 2002). The need for credit or government-provided financial incentives and seedlings all were identified as constraints by 84% or more of the farmers surveyed. Generally, wealth is recognised as a key contributor to agroforestry adoption, with wealthier farmers better able to understand and implement new technologies (Franzel and Scherr 2002). Interestingly, a separate survey of extensionists and technical assistance providers, conducted as part of this study, revealed that these groups felt that financial constraints would not limit agroforestry adoption in Cape Verde (Delgado 1996). In this study, wealth was not a key variable, because all the farmers were judged to be operating in a limited-resource environment.

Of all the common uses for planted trees, only three emerged in this study: planting for fuelwood (53%), planting for fruit (73%), and planting for shade (16%). Fuelwood is limiting in Cape Verde in general, but there is a trade-off between taking valuable agricultural land and using it for growing fuelwood. However, when the farmers understood the benefits of trees and the integrated nature of agroforestry (Vergara 1985), they were more positive. The only continuous or discrete variable related to farmer willingness to plant fuelwood trees was willingness to plant shade trees. All eight farmers who desired more shade trees also wished to plant more trees for fuelwood. These were most likely the farmers who were not concerned about the space issue. Of all tree crops in the Água de Gato Watershed, the only one with a significant economic component is fruit trees. Interestingly, gender and marital status showed significant relationships to willingness to plant trees for fruit production. Thirty-five of 45 men surveyed were interested in planting more fruit trees, many citing the possible sale of fruit as the reason. This recognition of the entrepreneurial aspect of agroforestry has been cited as a potential benefit for rural populations in Africa (Leakey 1998). Since men typically control family finances in the study area, they were logically more motivated than women to address the economic aspects of the tree crops.

Tree planting is generally a long-term endeavour, with the products not likely to emerge for many years. A study of a walnut agroforestry system in France (Mary *et al*. 1999) revealed that older farmers were more interested in growing longer-lived tree crops. This was speculated because older farmers could better appreciate the long-term nature of the enterprise and they never expected to harvest the products in their lifetimes anyway. Age did not emerge as a significant variable in any of the three scenarios investigated in this study, even though ages ranged from 22 to 86

years. Likewise, gender did not emerge as a major factor, except in the case of tree planting for fruit production, where 35 of 45 male farmers were willing to plant for this purpose, while only 2 of 6 female farmers were. Franzel and Scherr (2002) indicated that agroforestry adoption is typically lower for farms headed for women, because such farmers tend to have more limited resources and extension services generally target men more than women. Although not significant, in this study more women were willing to plant trees for fuelwood than not, but less were willing to plant trees for fruit production. This may be an indicator that labour concerns are more serious than income, because fruit is often sold, and fruit crops take years to produce. Having women strongly supportive of agroforestry adoption would assist in implementation; establishing tree crops for multiple purposes (e.g. both fruit and fuelwood) may assist as well.

These results have a number of implications for promoting more agroforestry adoption in Cape Verde. Real or perceived constraints must be dealt with, first and foremost including a means for providing a line of credit to assist with the initial investment in trees and tree planting. Farmers must know up front what their responsibilities will be with tending the trees and what their ownership rights to the products (e.g. fruit or fuel) will be upon maturity. It seems that farmers are ready to adopt more tree planting, given the appropriate conditions. The lack of significant relationships, for the most part, between farmer and farm characteristics and willingness to plant trees, shows that across age groups and size of farms, there is broad interest in and acceptance of agroforestry.

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